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CONTENTS

Fifth Annual Meeting 2

The Disposal and Recovery of Textile Waste Liquors. Maxwelton S. Campbell 3

The Microbiology of Textile Fibres (Cotton). Bryce Prindle 11

Testing the Crêpage of Yarns Before Weaving. Irving J. Saxl 32

Abstracts 36

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Fifth Annual Meeting

The Fifth Annual Meeting of U. S. Institute for Textile Research, Inc., will be held in the Small Foyer Ball Room of the Hotel Pennsylvania, New York City, starting with luncheon at 12:30 P.M., Thursday, November 1st.

During the luncheon the formal business of the members' meeting will be conducted and annual reports will be presented in abstract form.

Interpretation of Textile Research Results

Following the luncheon and business meeting President Garvan will present his annual address, and the remainder of the session will be devoted to a discussion of The Interpretation of Scientific Textile Research Results.

The discussion will be opened on the physical side by E. R. Schwarz, associate professor of textile engineering, Massachusetts Institute of Technology, Cambridge, Mass.; on the chemical side by Dr. Robert E. Rose, director, technical laboratory, Organic Chemicals Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., and president, American Association of Textile Chemists and Colorists.

Dr. Karl T. Compton, president of Massachusetts Institute of Technology, Cambridge, Mass.; chairman of the Advisory Committee of The Textile Foundation, and of the National Science Advisory Board, will be present as the guest of U. S. Institute and has promised to speak informally.

Members are urged to come prepared to take part in the discussion with constructive suggestions.

The Committee on Program is as follows: Dr. W. E. Emley, Chm., Dr. H. DeWitt Smith, Alban Eavenson, Prof. E. R. Schwarz, C. H. Clark.

Meetings of Board of Directors

The Board of Directors of U. S. Institute will meet in Parlor C of the Hotel Pennsylvania, New York City, at 11 A.M., Thursday, November 1st, to act upon the agenda previously received by members.

Immediately following adjournment of the corporation meeting, at which will be elected successors to directors whose terms have expired or who have resigned, a meeting of the Board of Directors will be held in Parlor C for the election of officers and committee members whose terms have expired, and for action upon unfinished business.

The Disposal and Recovery of Textile Waste Liquors

By MAXWELTON S. CAMPBELL *

Introduction

In order that the study of treatment and disposal of textile waste liquors might be conducted in the field on an experimental-plant-scale the Textile Foundation authorized the construction of such units as it was deemed necessary to make such an investigation possible.

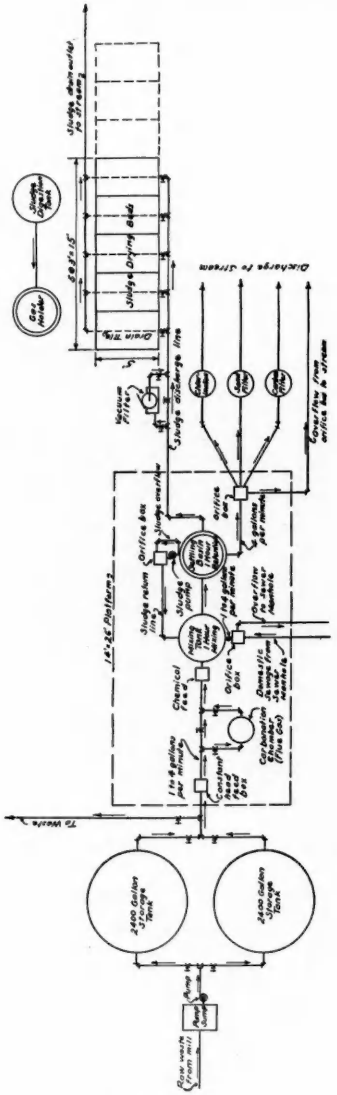
The units were accordingly built and installed at the Proximity Print Works, Greensboro, N. C. The site for the plant was chosen on the basis of availability of waste liquors and domestic sewage. Waste liquors from the printing of cotton goods, sulfur dyeing in jigs, bleaching, and dyeing of denim with indigo are available at the present site.

The experimental units constructed provide treatment by chemical precipitation, activated sludge, and biological filtration. The rates of treatment are as follows: chemical precipitation, four gallons per minute; activated sludge, two gallons per minute; and biological filtration at one gallon per minute.

The units are designed and constructed to be used interchangeably between the three types of treatment processes and consist of the following equipment: three mixing tanks of 240 gallon capacity; two settling tanks of 115 gallon capacity; one settling basin of 210 gallon capacity; one settling basin of 720 gallon capacity; and one trickling filter designed on the basis of a rate of filtration of four million gallons per acre per day.

The 720-gallon settling basin is herein referred to as a "surfasettler," since an auxiliary floor is used to increase the surface area for sedimentation; and the trickling filter is re-

* Mr. Campbell is a Junior Fellow of the Textile Foundation working under the direction of Dr. H. G. Baity, University of North Carolina, Chapel Hill, N. C.



FLOW SHEET No. 1.

ferred to as an activated filter, since it is operated not by straight filtration but by recirculation, which approaches the action of the activated sludge process.

The flow sheets for each of the three types of treatment, with a brief explanation of each, are as follows:

Chemical Precipitation Flow Sheet

Flow Sheet No. 1 shows diagrammatically how the units are assembled to provide treatment by chemical precipitation. The raw wastes from the mill, after being discharged from the vats, are collected in a pump sump. From the pump sump the wastes are pumped to the 2400-gallon storage tanks (Fig. 1). Since those liquors which do not run continuously to

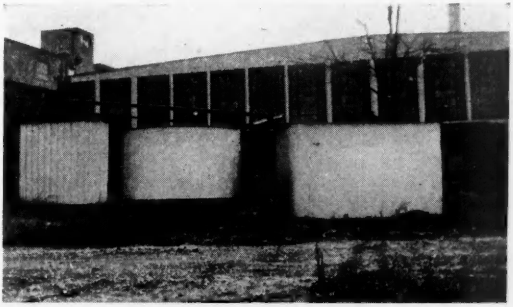


FIG. 1. Storage Tanks.

waste are discharged in large quantities over a short period of time, and whereas the experimental plant must operate at a low rate of flow over a long period of time, these storage tanks serve a dual purpose. First, they make it possible to store a large quantity of waste, just as it is discharged from the vats for treating throughout the day, without interfering with the time or rate at which the vat is ordinarily discharged. Second, they permit continuous treatment of the wastes at a constant rate throughout any one day, without regard to fluctuations in rate and quality of wastes as they are discharged from the mill. Consequently, two storage tanks are provided; one from which the waste collected the day prior to treatment is discharged at a constant rate to the treatment plant (Fig. 2), while at the same time the other is being filled for treatment on the following day. A waste line is provided in order that, when a run is finished, the waste remaining in the storage tanks may be discharged without passing through the plant.

For treatment by straight chemical precipitation (Fig 3) the wastes pass from the storage tanks through a constant-head feed-box, where the flow is regulated, to the chemical feed-box where the chemicals are added,

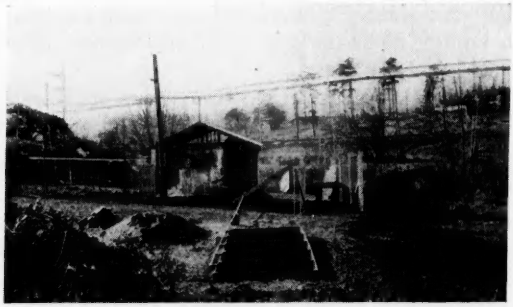


FIG. 2. View of Plant with Sludge Drying Beds in Foreground.

and thence to the mixing tank. The wastes and chemicals are mixed to effect coagulation and then pass over to the settling basin. Here the coagulated wastes settle out in the form of a sludge. The sludge may be dewatered on the vacuum filter, or drawn directly onto the sludge drying beds. A portion of the sludge from each day's run is placed in the sludge digestion tank for conversion to the stable form by bacterial decomposition, in order to determine the quantity and quality of the gas produced. The supernatant liquor from the settling basin flows to an orifice box (Fig. 4) where the flow is divided for after-treatment by chlorination, sand filtration, and activated carbon filtration. The efficiencies of the methods of final treatment may then be compared. The effluents from the final treatment units are discharged into the stream.

As a result of previous studies on a laboratory scale it was shown that, in some instances, a substantial decrease in the coagulant required for precipitating the wastes can be obtained by returning a portion of the precipitated sludge from the settling basin to the mixing tank and adding it along with the raw wastes and chemicals. The sludge return line provides for operation with recirculation of sludge.

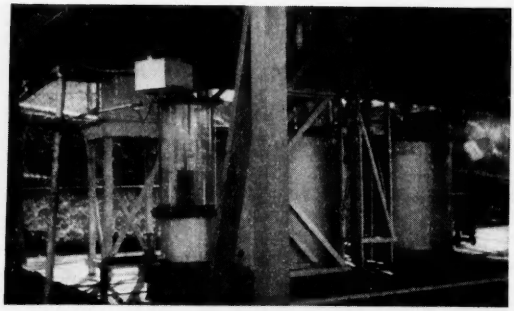


FIG. 3. Assembly for Chemical Precipitation.

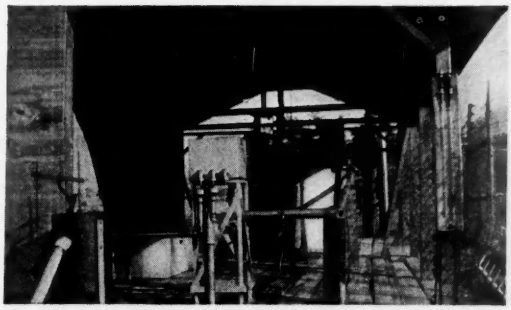


FIG. 4. View from Effluent End of Plant with Orifice Box and Sand Filter in Foreground.

A further reduction in the required chemicals can be effected, in some cases, by bringing the pH of the raw wastes down to the point of coagulation by carbonation with flue gas, and then adding the coagulant.

The units are so connected with facilities for by-passing that the types of treatment by chemical precipitation can be readily shifted from one to the other for purposes of comparison.

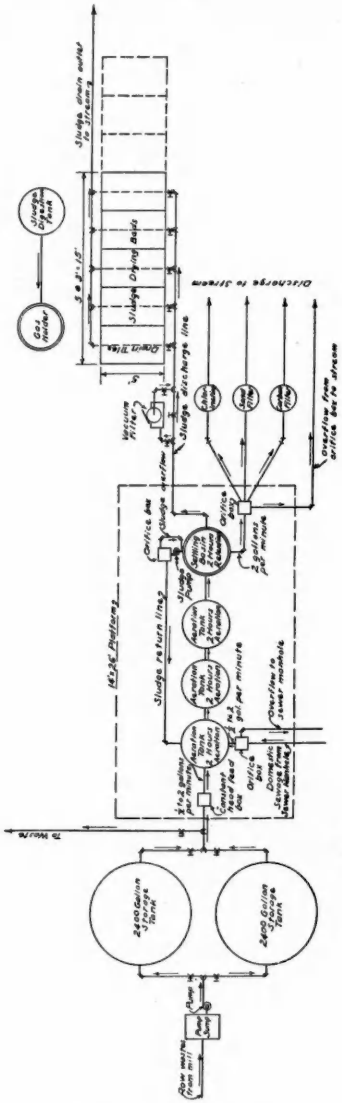
Provision is made for studying the treatment of combined textile wastes and domestic sewage with chemical precipitation by introducing sewage into the mixing tank through the orifice box on the line from the sewer manhole. By adjustment of the flow of wastes through the constant-head feed-box, and varying the quantity of domestic sewage flowing through the orifice box on the sewage line, the combined wastes can be mixed for treatment in any proportion desired.

Activated Sludge Flow Sheet

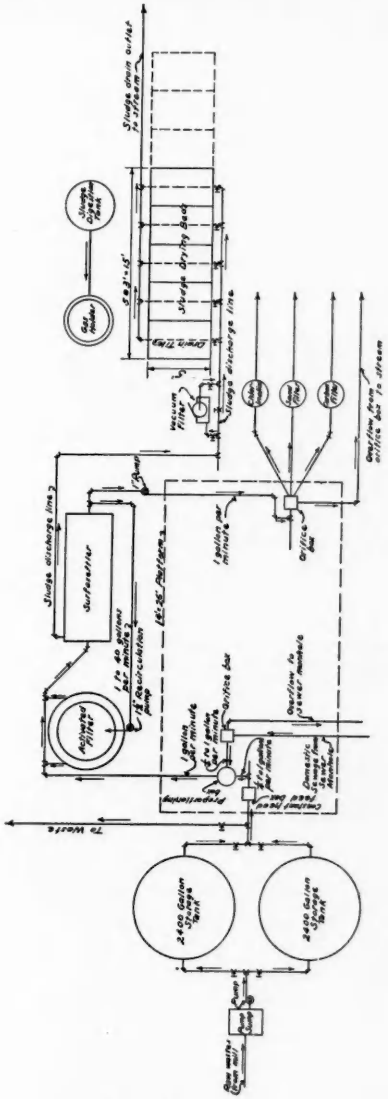
The arrangement of the units for treating the wastes by the activated sludge process is shown on Flow Sheet No. 2. The use of the storage tanks is the same as described for chemical precipitation. The only change in the equipment from that used for chemical precipitation is that two additional mixing tanks are provided and all three mixing tanks function as aeration tanks in series. Aeration is supplied by mechanical means, the mixing apparatus in the mixing tanks being operated at a considerably higher rate of speed than that used for chemical treatment. Since no chemicals are used in this process the chemical feed box is eliminated.

This type of treatment is biological and depends, therefore, on the organisms and organic matter supplied by the domestic sewage. Consequently, this treatment will be of combined textile wastes and domestic sewage at all times. The proportions of the wastes and sewage may be varied by controlling the flow through the constant-head feed-box and orifice-box, which feed into the first aeration tank.

The process as ordinarily carried out consists of adding sludge to the raw sewage and waste liquors in the proper proportions; roughly, so that the returned sludge is from 5 to 25% by volume of the mixed liquor in the



FLOW SHEET NO. 2.



FLOW SHEET NO. 3.

aeration tanks; of introducing sufficient air to provide enough dissolved oxygen to maintain aerobic conditions, and of agitating the mixture until practically all of the suspended and colloidal matter has been flocculated, or adsorbed by the floc introduced into the sewage and wastes. The mixture is then conducted to the sedimentation tank where the floc is removed by sedimentation and the clear supernatant liquor flows away as effluent. That portion of the sludge which is not required for the treatment of the incoming combined sewage and waste liquor is diverted and dried, on either the sludge drying beds or vacuum filter.

The combined wastes pass through the three aeration tanks where they receive six hours of agitation and aeration. The sludge which forms, as a result of this treatment, is allowed to settle in the settling basin which provides two hours sedimentation. A portion of the sludge from each run is added to the sludge digestion tank to determine its gas production. The supernatant liquor from the settling basin is given the final treatment of chlorination, sand filtration and carbon filtration.

Biological Filtration Flow Sheet

Flow Sheet No. 3 shows the assembly of the units for treating the combined textile wastes and domestic sewage by biological filtration.

The path of flow is as follows: The waste liquors pass from the storage tanks through the constant-head feed-box, where they are metered, and flow into the proportioning box. At the same time raw domestic sewage is being pumped from the sewer manhole up to the orifice box, where its flow is metered and then passed into the proportioning box. The wastes and domestic sewage, then, by regulation of the constant-head feed-box and orifice-box, can be mixed in any desired ratio. From the proportioning box the combined wastes flow at a one-gallon-per-minute rate to the "surfasettler," where they are retained for a period sufficient to allow the suspended solids to settle. The recirculation pump lifts the combined wastes, after sedimentation, to the top of the activated filter, where they are allowed to trickle down through the filter bed and then flow back to the "surfasettler."

The sludge developed by the filtration process then settles in the "surfasettler" and is drawn off through the sludge discharge line, either to the vacuum filter, or to the sludge drying beds. A portion of the sludge from each run is added to the sludge digestion tank.

The supernatant liquor from the "surfasettler" is drawn off at the same rate at which it enters the system from the proportioning box in the form of combined raw wastes (one gallon per minute) and pumped to the orifice box on the platform, where it is divided for final treatment. Although the rate of flow of the combined wastes entering the plant, and the supernatant liquor leaving the system, is held constant at one gallon per minute, the rate of recirculation through the filter may vary from one to 40 gallons per minute.

The Microbiology of Textile Fibres *

(Cotton)

By BRYCE PRINDLE †

Abstract

By the application of previously reported[4] methods of microbial analysis, the micro-flora of a series of 12 samples of cotton fibre has been completely studied and the analysis of five additional samples has been partially completed.

Analysis of the experimental results indicates that the original and principal infection of cotton fibre is with organisms of the genera commonly associated with the soil. There is evidence to show that a high percentage of the microbic population of the cotton boll may be carried over into the cleaned fibre or even into the spun and woven fibres.

Examination of stored samples, together with a study of the types of organisms remaining alive after storage, indicate that many of the original contaminants die during the course of a long storage leaving the hardier spores, and a few highly resistant vegetative types, viable. Cultural studies indicate that the contaminants of the unstored samples might be expected to be more active in producing changes in the fibre and its associated materials because of their ready growth on such substances as cellulose, starch, and gelatin.

Conclusions

FROM the complete analysis of the micro-flora of 12 samples of cotton fibre and the partial analysis of five samples, the following conclusions are drawn:

1. All samples of commercial raw cotton were found to have a high degree of infection with molds and bacteria. The numbers per gram found in fresh samples of raw fibre have the fol-

* This investigation has been carried out in partial requirement of the work for the degree of doctor of philosophy at the Massachusetts Institute of Technology, is published with the permission of the Department of Biology and Public Health, and is Contribution No. 37 from the department.

† Mr. Prindle is a Junior Fellow of the Textile Foundation working under the direction of Dr. S. C. Prescott, Massachusetts Institute of Technology, Cambridge, Mass.

lowing limits: bacteria, 4.0×10^6 to 58×10^6; molds, 120,000 to 400,000.

2. The principal part of the microbial flora of raw cotton were found to be soil organisms, or organisms commonly found in fresh plant tissues and material.

3. Evidence as to the relative numbers and kinds of organisms found in freshly collected, and in stored samples indicates that a large percentage of the original micro-flora dies during long storage.

4. There is evidence that the contamination of raw cotton is evenly distributed on clean fibre and on waste material and is, therefore, only partially removed by mechanical cleaning.

5. Unstored samples of cotton fibre were found to contain large numbers of non-spore-forming soil bacteria, and molds of the genera *Hormodendrum, Fusarium,* and *Alternaria,* with *Aspergillus* and *Penicillium* in smaller numbers. Stored samples contained largely spore-forming bacteria of soil type, and molds of the genera *Aspergillus* and *Penicillium.*

6. The bacteria common to all samples were, in general, protein digesters and showed little action toward carbohydrate media with the exception of acid formation in glucose broth.

7. *Aspergilli* and *Penicillia* characteristic of the stored samples were able to utilize starch in synthetic medium readily. They showed but slight action toward gelatin and cellulose. All three of these nutrients were found to serve as food materials to the majority of the molds isolated from unstored samples.

Review and Introduction

IN a previous communication[4] we have reported the first year of work in a research in the field of textile microbiology. In making a choice of fibres for study, preference was given to those of major importance; *i.e.,* wool, silk, flax, and cotton. After due consideration of the properties of these four fibres and the state of knowledge concerning them, cotton was chosen as the first to be studied because of its tremendous economic importance and because of the fact that its structure is relatively simple and well worked out (from the biologist's standpoint). The first report, therefore, deals principally with cotton fibre. Two phases of the research were reported:

1. The completion of an extensive survey of the literature of cotton fibre micro-biology.
2. Development of original methods for a laboratory research in that field.

The survey of the literature was presented in the form of abstracts, catalogued according to date of publication and author. This was supplemented by a brief discussion of the subject matter and a brief subject index of the abstracts. Articles dealing with all aspects of the problem, such as mildew, mildew antiseptics, cotton fibre structure, microbic content of fibre samples, fermentation of cellulose, and related subjects, with the exception of a voluminous literature on cotton plant diseases, have been included in the abstracts.

In the laboratory, methods for the study of the microbic population of the cotton fibre were developed. The object of this part of the research was to obtain as complete and undistorted a picture of that population as possible. To accomplish this it was necessary to have a system of analysis such that, upon application to widely varying types of fibre samples, it would reveal the following:

1. The total numbers of organisms on the sample.
2. The different types of organisms present.
3. The approximate relative abundance of the different types.

It was also desired that pure cultures of the various contaminants might be obtained for further study.

The following system of micro-biological analysis was developed for obtaining the desired information, and to date has proved satisfactory for samples of raw cotton fibre:

Collection and Storage—

1. Samples of raw fibre are collected aseptically and placed in sterile glass jars having rubber gaskets. These are immediately sealed.
2. The collected samples are stored in the sealed jars at room temperature in the dark until ready for study.

Procedure of Analysis—

3. Small tufts of the cotton are thrust, with aseptic precautions, into a narrow glass tube, cut up with scissors and allowed to fall into a tared, sterile, glass weighing bottle.
4. After weighing to 1.00 gram $\pm$ 0.02 gram, the sample is violently shaken with 99 cc. dist. aq. and 20 grams broken glass, 4–12 mesh size for five minutes.
5. Part of the water which then contains much debris from the cotton is poured off and diluted with distilled water in the regular bacteriological manner for making plate counts. After an incubation period of four days at 25° C., the colonies are counted and cultures of the various types of colonies present are transferred to agar slants for further study and identification. To aid in the differentiation of microbic types, three media have been used. They are as follows:

   (*a*) Czapek's agar acidified to pH 4.2 with citric acid.
   (*b*) Nutrient agar.
   (*c*) Synthetic malt agar.

Preliminary results obtained in the course of development of this analytical procedure have established the following:

1. That cotton fibre has a large and quite varied micro-flora which can be successfully separated from the fibre and studied in the laboratory.
2. That certain of the molds and bacteria which occur as contaminants of raw cotton fibre are capable of growing vigorously upon it under adequate conditions of moisture, temperature, and aeration.

Experimental Work

Since the period last reported (TEXTILE RESEARCH, 1933, Vol. III, No. 10, P. 475–78; 1934, Vol. IV, No. 9, P. 413–28; No. 10, P. 463–78) the research has developed along two lines:

(A) Further development of laboratory methods.
(B) Application of methods to cotton fibre study.

(A) *Further Development of Laboratory Methods.*

Before regular studies of the microbic content of cotton samples were started, the system of analysis previously formulated was carefully reviewed; whereupon the question of culture media for counting the fibre contaminants again came to the fore. It was felt that many of the molds and bacteria closely associated with the cotton fibre might not find suitable conditions for growth on the common laboratory media employed. In addition, it was desired to obtain some indication of the numbers and kinds of micro-organisms capable of using the food substances of the cotton fibre. To obtain this valuable information, and to avoid losing important cultures, a new medium was made from raw cotton fibre.

An attempt was first made to use the whole fibre, but this was quickly abandoned when it became evident that dispersion of the cotton fibre, which would be necessary in a medium used for making bacterial counts, was not feasible without marked changes in the constitution of the fibre and its associated substances.

Synthesis of a medium in which the nutrients of the cotton fibre should be the principal constituents was therefore undertaken. The water-soluble substances of the fibre were extracted in the following manner:

1. 100 grams of the fibre sample to be examined was finely divided with shears.
2. The cut fibre was then immersed in water (1000 ml.) overnight at 10° C.
3. 500 ml. of liquid was withdrawn and replaced with 500 ml. of boiling water.
4. The cotton and water mixture was heated for one-half hour at 100° C.
5. 500 ml. of the hot liquid was pressed out and mixed with the cold extract. The combined liquid was used as a nutrient broth.

In early experiments, using the broth as a base for media, cellulose, in the form of Whatman's No. 1 filter paper, was added as a substitute for the cotton fibre cellulose. It was used as strips in tubes of broth, and as a suspension in agar media. Upon plating out the organisms washed from cotton fibre in the solidified medium, or upon inoculating them into the

broth, an abundance of bacterial growth was obtained in the space of four-day's incubation at 25° C. Mold growth, on the other hand, was much less vigorous than on the fibre itself or on the artificial media.

In spite of the occurrence of heavy bacterial growths there was no sign of cellulose digestion in either type of medium, even after long incubation. Agar plates were incubated for two to three weeks without any sign of dissolution of the cellulose fibres. Tubes of broth became very turbid, but showed no indications of attack on the filter paper strips, even after an incubation period of three months.

From the results of the experiments mentioned it seemed probable that the filter paper cellulose did not serve as an important nutrient material for most of the micro-organisms which occurred on the cotton samples. Because of the difficulty of counting colonies on agar plates containing fibres of cellulose, an experiment was performed to determine the possibility of omitting them.

A series of plates containing cellulose fibres and cotton extract agar as nutrients, and a second series containing only cotton extract agar, were inoculated and poured. The organisms in a single suspension from one cotton fibre sample were used for the inoculation. These cultures were incubated for 4-days at 25° C. A comparison of the counts recorded for each series shows that (1) higher counts of bacterial colonies were obtained on the clear agar in every case; (2) mold counts were about equal on the two media. The plates were then recounted several times. It was found that the recount values for the fibre-containing plates were much more variable than those for the clear plates, thus demonstrating the fact that many bacterial colonies are obscured by the presence of the filter paper fibres. The types of colonies which developed on the two media were macroscopically identical. These observations were taken as conclusive evidence that cellulose fibres in the cotton extract medium do not serve as an important nutrient for the microbic contaminants of cotton fibre during the 4-day period of incubation used in the standard counting procedure.

The clear cotton extract agar or broth, without cellulose, has been subsequently used, and fills the need for a medium which will show, for any particular cotton sample, which of its contaminants are capable of utilizing the water-soluble substances of the fibre for their growth processes. It will, therefore, provide an index of the bacteria and molds which can quickly gain a foothold on the fibre in the presence of favorable conditions. Whether such growth is capable of bringing about important changes in the properties of the fibre, is the subject of a future study.

(B) *Application of Methods to Fibre Samples.*

Having completed the plan of analysis by addition of a cotton extract-medium, we now proceed to a consideration of the results attained by the use of this method.

At the beginning of the period with which this report is concerned, several samples of raw unginned cotton, and cotton sliver collected from various New England mills, were at hand. These had been stored in glass jars in the dark at room temperature for nearly a year. This stock was augmented by samples of unginned raw cotton from various southern states at the end of the summer season. These were similarly stored. At a later date, fresh samples of ginned cotton from the opening room of a mill were added to the collection.

Altogether, five groups of cotton samples have been studied in the following order:

1. Stored, ginned, raw cotton.
2. Stored cotton sliver.
3. Cotton from recently harvested bolls.
4. Fresh samples of ginned cotton from a mill.
5. Fresh waste from a picking machine.

Experimental Procedures

Observation of Plates and Isolation of Cultures—In studying these groups of samples, the standard procedure previously worked out was closely followed. (See TEX. RSCH., IV, 12, 555, 1934.) Plates for counting the number of micro-organisms present were made in duplicate. After counting and observations as to the kinds of organisms found on each sample, cultures were transferred to agar slants for further study. The predominant types were chosen for isolation. Great care was exercised in the choice of colonies for this pure culture study, in order that they should be representative of the numerous types, rather than of the large or brightly colored, which tend to obscure less noticeable colonies on many plates. At the time of isolation a number was assigned to each culture, showing the sample from which it came, whether it was mold-like or had a bacterial type of colony and a specific number. A percentage was also recorded for many of the more abundant type of colonies. This figure is an estimate of the abundance of that type of colony and represents, not the percentage of the total colonies (both molds and bacteria) which is of the type, but the percentage of molds, or bacteria of mold- or bacteria-like colonies on a series of plates of the same medium, which are of the type in question. Thus, culture 11 M 15, 70%, means that culture number 15 from sample number 11 was a mold-like organism. If isolated from Czapek's agar, for example, it represents 70% of the total mold colonies which developed on that medium in the series of plates made from sample number 11.

Pure Culture Studies—After isolation, the cultures were freed from contaminants, if necessary, and then examined microscopically and culturally for identification and for information concerning their ability to attack protein and carbohydrate material.

Microscopical Studies

Molds were examined for habit of growth, colony formation, color, mode of spore formation, and general morphology. Colonies growing on plates of Czapek's agar were used for these observations.

A method which was very helpful in examining spores of such cultures under the oil immersion lens of the microscope, was to smear a cover glass lightly with clear lacquer, drop this or touch it lightly, depending on the type of colony, onto the colony, wet side down. Many spores will adhere to the lacquered surface. It is then removed and allowed to dry. After staining for 10 seconds with 0.5% aqueous safranin-o, and washing with water, the preparation may be mounted in Canada balsam or Gum Damar for examination. Best results are obtained if the cover glass and spores are handled, stained, and washed very gently.

The microscopical study of bacterial cultures included observations as to size and shape of organisms, occurrence of spores, motility, and reaction to the Gram stain. These observations were all made in duplicate. Hucker's modification of the original Gram stain was used for determining the reaction of 24-hour-old cultures of all bacterial types. The presence or absence of endospores was determined by the use of the technique of Schaeffer and Fulton.[5] Cultures 48-hours to 10-days old were studied by means of this stain.

Biochemical Studies

Cultural Studies—Cultural studies of both molds and bacteria were designed to show the possible significance that the microbe might have in relation to the fibre under conditions of manufacture and use. In the case of molds, this was limited to determinations of their ability to utilize cellulose, starch, and gelatin in their growth processes. The studies on bacteria were further extended, for purposes of more detailed information and identification, to their reactions toward the following substances:

Carbohydrates ..Cellulose, starch, dextrin, maltose, lactose (in milk), and glucose.
Proteins .....Milk, gelatin.
Miscellaneous ...Nutrient agar, nutrient broth, nitrate agar.

Culture Media—For the uses mentioned various media were used. They are listed here with their uses and descriptions:

(A) *Mold Media.*

1. Solid.
   (*a*) Gelatin.—Dehydrated nutrient gelatin was used. This was inoculated by the stab method and observed for the following:
      (*a*) growth.
      (*b*) liquefaction.
      (*c*) reaction, using phenol red which changes from yellow to red at pH 6.8–8.4.
   (*b*) Czapek's agar solution (neutral). As previously reported. For observations on morphology and color.
   (*c*) Synthetic starch agar. An agar containing inorganic salts and starch. (See Appendix.)
2. Liquid.
   (*a*) Cellulose broth. A broth containing inorganic salts and filter paper cellulose. Used for observations of ability of molds to grow upon and disperse cellulose. (See Appendix.)

(B) *Media for Bacteria.*

1. Carbohydrate.
   (*a*) Cellulose. Same broth used as for molds. Observations for growth and disintegration of filter paper strip were made.
   (*b*) Starch. Dehydrated starch agar was used. Inoculation was accomplished by streaking slanted tubes, and iodine was used to determine the degree of starch hydrolysis.
   (*c*) Dextrin. A 1% suspension of purified dextrin (see Appendix for method of purification) plus inorganic salts, as in the case of cellulose broth, was used. Gas and acid observed.
   (*d*) Maltose and dextrose broths. These media were made by dissolving 5 grams of the sugar in nutrient broth; 1000 ml.

utilization of sugar judged by growth of bacteria; reaction of medium to Brom-cresol purple, and formation of gas.

(*e*) Litmus milk. The formation of acid or gas was observed in litmus milk. A dehydrated medium was used.

2. Protein.

(*a*) Litmus milk. Dehydrated medium used. Observations were recorded for formation and digestion of curds. Reduction of the litmus and occurrence of an alkaline reaction were also noted.

(*b*) Nutrient gelatin. A dehydrated medium was used. Observations were recorded for growth, and liquefaction.

3. Miscellaneous.

(*a*) Nutrient broth and agar. Used for growing organisms for microscopical study.

(*b*) Nitrate agar. Slants used for determination of reduced nitrates.

Key to Symbols used on Data Sheets

CULTURE NUMBERS

Example. 11 M 7-Culture number 7 from sample 11 is mold like. See page (16) of text for further explanation.

PERCENTAGES

Example. 11 M 2, 75%, —75% of molds occurring on Czapek's agar are of type 11 M 2. See page (16) of text for further explanation.

SIGNS

Gram stain. +, positive; —, negative; ±, variable.
Spores. +, present; O, absent.
Motility. +, present; O, absent.
Cellulose, Starch. +, digestion, or growth on; O, no change.
Dextrine, Maltose, Glucose. O, no action; A, acid; G, gas.
Litmus Milk. R, reduced
P, peptonized
A, acid
R–C, rennet curd
A–C, acid curd.
Gelatin. +, liquefaction; O, no liquefaction.
Nitrate agar. O, no reduction; NO_2^-, reduced to nitrites.
Chromogenesis. Bl, black G, green
Br, brown Or, orange
B, blue P, pink
Y, yellow W, white
R, Red Gr, grey
O, none

Experimental Data

A total of 17 cotton samples has been studied. Of these, observations have been completed on 12, and 5 have been studied partially. The data collected from these studies follows in the order in which the five groups of samples were classified.

Stored Samples of Raw Cotton

These samples were collected from various New England mills. Upon receipt at the laboratory they were placed immediately in tightly closed glass jars and stored in the dark at 20° C. At the time of their examination they had been in storage about one year.

Sample No. 3. Tennessee cotton taken aseptically from the outside of a bale at the mill opening room; somewhat soiled by handling and shipping.

SAMPLE NO. 3

DESCRIPTION. Raw cotton, Tennessee, From bale at mill

DATES. Collected – July 1, 1932 Cultures made – July 20, 1932

TOTAL COUNTS

Culture media	Bacteria	Molds	
Czapek's agar acidified		<100	per gram
Synthetic malt agar	250,000 ; 240,000	<100	
Nutrient agar	2,200,000		
Cotton extract agar			

PURE CULTURE CHARACTERISTICS

No.	Genus	%	Microscopical				Cultural									Habitat (Probable)
			Gram stain	Spores	Motility	Size in μ	Cellulose	Starch	Dextrin	Maltose	Glucose	Litmus milk	Gelatin	Nitrate agar	Chromogenesis	
3B1	Bacillus	–	+	+	+	0.7 x 1.6	0	0	0	0	A	PR	+	0	0	Soil
3B2			±												0	
3B3			–												Y	
3B4															Y	
3B5															Y	

SAMPLE NO 13

DESCRIPTION. Best Soudan, raw cotton (From bale at mill)

DATES. Collected – Aug 10, 1932 Cultures made – Aug 17, 1933

TOTAL COUNTS

Culture media	Bacteria	Molds	
Czapeks agar acidified		85 , 45	per gram
Synthetic malt agar	49,000 , 21,000	1200,1300	
Nutrient agar	800,000; 850,000		
Cotton extract agar	1.2×10^6 , 1.6×10^6		

PURE CULTURE CHARACTERISTICS

No.	Genus	%	Microscopical				Cultural										Habitat
			Gram stain	Spores	Motility	Size in μ	Cellulose	Starch	Dextrin	Maltose	Glucose	Litmus milk	Gelatin	Nitrate agar	Chromogenesis		(Probable)
13M1	Aspergillus	90													Br-W		
13B2	Serratia		+	0	+	0.8x1.1	0	0	0	0	0	0	0	0	P		Soil
13B3			+	0	0	0.7 dia	0	0	0	0	0	0	0	0	Y		
13B4	Flavobacterium		–	0		0.5x1.6	0	0	0	0	0	P.R	+	0	Y		Air
13B5	Flavobacterium		–	0	+	0.8x1.1	0	0	0	0	0	ACR	0	NG	Y		Soil
13B6	Micrococcus	35	±	0	0	0.8 dia	0	0	0	0	0	0	+	0	Y		Soil, Air
13B7	Flavobacterium	90	–	0	0	0.5x1.6	0	0	0	0	0	R-C, P.R	+	0	Y		Soil, Air
13B8	Micrococcus		±	0	0	0.8 dia.	0	0	0	0	0	0	+	0	Y		Soil, Air

SAMPLE NO 11

DESCRIPTION. Raw Pima cotton

DATES. Collected – June 14, 1932 Cultures made – July 28, 1933

TOTAL COUNTS

Culture media	Bacteria	Molds	
Czapeks agar acidified		680, 660	per gram
Synthetic malt agar	1,100 , 2,600		
Nutrient agar	40,000 , 37,000		
Cotton extract agar			

PURE CULTURE CHARACTERISTICS

No.	Genus	%	Microscopical				Cultural										Habitat
			Gram stain	Spores	Motility	Size in μ	Cellulose	Starch	Dextrin	Maltose	Glucose	Litmus milk	Gelatin	Nitrate agar	Chromogenesis		
11M1	Mucor						0								Br-Bl		
11M2	Aspergillus	75					+	+						+	Bl-W		
11M3		20															
11M4	Aspergillus	10					+	+						+			
11M5	Penicillium						+	+						+		G-Y	
11M6	Aspergillus															Br-W	
11M7		25															
11B1	Bacillus		+	+	+	1.3x1.5	0	+	A	A	A	P.R	+	NG	0		Soil
11B9	Flavobacterium		+	0	+	0.5x0.7	0	0	0	A	A	R	0	NG	Y		Soil, air
11B10	Bacillus		+	+	+	0.5x1.5	0	0	0	0	A	R	+	0	0		Soil
11B11			±			0.5x1.7	0	0	0	0	0	R.B	0	0	0		
11B12	Bacillus		–	+	+	0.3x1.6	0	0	0	0	A	P.R.B	0	NG	Y		
11B13	Flavobacterium		–	0	+	0.5x1.2	0	0	0	A	A	R	0	NG	Y		
11B14	Bacillus		+	+	+	1.6x3.0	0	+	0	0	A	P.R	0	0	Br		Soil
11C15			+			0.5x1.8											
11B16	Bacillus		+	+	+	0.3x1.7	0	+	A	A	A	P.R	+	NG			Soil
11B17			±	0		0.5x0.7											

SAMPLE NO 18

DESCRIPTION Av Gov't Baled, raw cotton

DATES Collected— Aug 10, 1932 Cultures made — Aug 12, 1933

TOTAL COUNTS

Culture media	Bacteria	Molds	
Czapek's agar acidified		350	per gram
Synthetic malt agar	114,000		
Nutrient agar	150,000		
Cotton extract agar	340,000		

PURE CULTURE CHARACTERISTICS

No.	Genus	%	Microscopical				Cultural										Habitat
			Gram stain	Spores	Motility	Size in μ	Cellulose	Starch	Dextrin	Maltose	Glucose	Litmus milk	Gelatin	Nitrate agar	Chromogenesis		(Probable)
18M1	Oospores/Mold	80															Soil
18M2	Penicillium	10					+	+					0		G-R		
18B3	Bacillus	15	+	+	+	0.5x1.6	0	0	0	0	A	B,R	+	0	0		Soil
18B4	Flavobacterium	20	−	0	+	0.6x1.0	0	0	0	A	A	B,R	+	NO_3	Y		Soil
18B5		10															
18B6			±			0.6x1.9											
18B7	Bacillus		±	+	+	0.5x1.4	0	0	0	0	A	B,R	+	0	0		Soil
18B8	Flavobacterium	50	−	0	+	0.5x1.2	0	0	0	0	A	$A-C_{12}$ R	+	NO_3	Y		Soil
18B9	Flavobacterium	25	−	0	+	0.6x1.1	0	0	0	A	A	A,R	+	NO_3	Y		Soil

SAMPLE NO 16

DESCRIPTION Baled, raw, Medium Sahel cotton

DATES Collected— Aug 10, 1932 Cultures made — Aug 10, 1933

TOTAL COUNTS

Culture media	Bacteria	Molds	
Czapek's agar acidified		1,300 , 3,000	per gram
Synthetic malt agar		400,000 , 470,000	
Nutrient agar	121,000 , 127,000		
Cotton extract agar	99,000 , 105,000	320,000 , 400,000	

PURE CULTURE CHARACTERISTICS

No.	Genus	%	Microscopical				Cultural										Habitat
			Gram stain	Spores	Motility	Size in μ	Cellulose	Starch	Dextrin	Maltose	Glucose	Litmus milk	Gelatin	Nitrate agar	Chromogenesis		(Probable)
16M1	Aspergillus	95													B-Y		
16M2		1															
16B3	Xurthia	35	+	0		0.5x1.2	0	0	0	0	0	0	0	0	0		Decaying Material
16B4	Achromobacter		−	0	+		0	0	0	0	A	B,R	0	NO_3	0		Mature Air
16B5	Micrococcus		+	0	+	0.7 dia	0	0	0	0	0	0	+	NO_3	0		Soil, Air
16B6	Achromobacter		−	0	+	0.6x1.5	0	0	0	0	0	0	+	NO_3	0		
16M7	Aspergillus						0	0					+		B-Y		Soil
16B8	Actinomyces						+	+					+		G		Soil
16B9			−	0	+	0.9x0.7	0	0	0	A,G	A,G	B,R	+	NO_3	0		

* Sample No. 11. Raw, ginned Pima cotton.
Sample No. 13. Raw, ginned, best Soudan cotton.
Sample No. 16. Baled, raw, medium Sakel, cotton.
Sample No. 18. Raw, ginned cotton from the same mill as No. 13; classified as Av. Gov't. 1 11/32 in.

Samples of Stored Cotton Sliver

These samples were collected by persons other than the author at various New England mills. They were collected and studied in the same manner as described for samples number 11, 13, 16, and 18, and are slivers made from raw cotton corresponding to the samples though probably not from the same bales. All were clean and dry when stored.

Sample No. 12. Pima cotton drawing sliver from same mill as No. 11, raw.
Sample No. 17. Medium Sakel drawing sliver from same mill as No. 16, raw.

Ripe Bolls from New Cotton Crop

This set of samples was obtained through the kindness of the Agricultural Experiment Stations of several cotton growing states. They were shipped to the laboratory by mail and express at the end of the summer season. An attempt was made to obtain these with as litttle contamination as possible after removal from the plants in the field. Samples were picked from the ripe bolls and subjected to the system of analysis without removing the seeds.

Sample No. 22. Samples from ripe bolls from College Station, Brazos Co., Texas; variety T. S. No. 18994, D. P. L. No. 10.
Sample No. 23. Samples from ripe bolls from College Station, Brazos Co., Texas; variety T. S. No. 7000, Startex 619.
Sample No. 24. Samples from ripe bolls of variety T. S. No. 18985, Now Boykin; from College Station, Brazos, Texas.
Sample No. 25. Ripe bolls of variety Dixie Triumph; from State Experimental Station, Louisiana.

Samples of Cotton and Waste From a Mill

Samples of ginned, raw, Mississippi cotton were collected with aseptic precautions from the opening room of a New England mill. They were taken by drawing small tufts of cotton from various points at the inside or outside of the bale. These samples were placed in glass jars and immediately sealed. Five days elapsed between the time of taking samples

* Note: These samples were obtained from mills and were collected by persons other than the author. They were not taken aseptically but large samples, 2–3 pounds, were taken in a single piece and well wrapped in brown paper. Small samples for laboratory study were taken from the inside of these bundles where it seemed most unlikely that the fibre could have been touched during collection and wrapping. All of this group were clean and dry when received.

SAMPLE NO 17

DESCRIPTION. Medium Sakel cotton sliver

DATES. Collected – Aug 10, 1932 Cultures made – Aug 28, 1932

TOTAL COUNTS.

Culture media	Bacteria	Molds	
Czapek's agar acidified		85 , 70	per gram
Synthetic malt agar	15,000 , 17,500	800 , 1,100	
Nutrient agar	64,000 , 62,000		
Cotton extract agar	71,000 , 70,000		

PURE CULTURE CHARACTERISTICS.

No.	Genus	%	Microscopical				Cultural										Habitat
			Gram Stain	Spores	Motility	Size in μ	Cellulose	Starch	Dextrin	Maltose	Glucose	Litmus milk	Gelatin	Nitrate agar	Chromogenesis		(Probable)
17M1		10															
17M2	Aspergillus	90					0	+						+		BW	
17B3		50	+	0	+	0.5x1.5	0	0	0	0	A	R	+	0	0		
17M4	Actinomyces	10					+	+						+		Gr	Soil
17B5		25															
17B6		25															
17B7		10															
17B8	Bacillus	5	+	+	+	0.3x1.3	0	0	0	0	A	R	+	0	0		Soil
17B9	Bacillus	30	–	+	+	0.3x1.3	0	0	0	0	A	R	+	0	0		Soil
17B10	Bacillus	10	–	+		0.3x1.3	0	0	0	0	A	R	+	0	0		Soil

SAMPLE NO 12

DESCRIPTION. Pima cotton sliver (Drawing frame)

DATES. Collected – June 14, 1932 Cultures made – July 19, 1933

TOTAL COUNTS.

Culture media	Bacteria	Molds	
Czapek's agar acidified		80, 90	per gram
Synthetic malt agar	8,000 , 4,600	<100	
Nutrient agar	38,000 , 34,000		
Cotton extract agar			

PURE CULTURE CHARACTERISTICS.

No	Genus	%	Microscopical				Cultural										Habitat
			Gram Stain	Spores	Motility	Size in μ	Cellulose	Starch	Dextrin	Maltose	Glucose	Litmus milk	Gelatin	Nitrate agar	Chromogenesis		(Probable)
12M1	Penicillium						+	+						0		G-W	
12M2	Aspergillus						0	0						+		BW	
12M3	Hormodendrum						+	+						+		G	
12B4																	
12B5																	
12B6	Bacillus		+	+	+	0.5x1.3	0	0	0	0	0	RB	+	0	0		Soil
12B7	Bacillus		+	+	+	0.7x1.5	0	0	0	0	A	RP	+	0	0		Soil
12B8	Bacillus		+	+	+	0.5x1.5	0	0	0	0	A	RP	+	0	0		Soil
12B9	Bacillus		+	+	+	0.8x1.6	0	0	0	0	0	RP	+	0	0		Soil
12B10	Bacillus		+	+	+	0.6x1.8	0	0	0	0	A	RP	+	0	0		Soil
12B11	Bacillus		+	+	+	0.8x1.6	0	0	0	0	A	R	+	0	0		Soil

SAMPLE NO. 23

DESCRIPTION. New bolls, Texas cotton

DATES. Collected — Sept. 21, 1933 Cultures made — Oct. 2, 1933

TOTAL COUNTS

Culture media	Bacteria	Molds	
Czapeks agar acidified	105,000 ; 135,000	420,000 ; 500,000	per gram
Synthetic malt agar	21.5×10^6 ; 22.5×10^6	400,000 ; 450,000	
Nutrient agar	36.0×10^6 ; 36.0×10^6		
Cotton extract agar	26.0×10^6		

PURE CULTURE CHARACTERISTICS

No.	Genus	%	Microscopical				Cultural										Habitat
			Gram stain	Spores	Motility	Size in μ	Cellulose	Starch	Dextrin	Maltose	Glucose	Litmus milk	Gelatin	Nitrate agar	Chromogenesis		(Probable)
23B1		5	—			1.0 dia											
23M2		5					+	+					+		V-R		
23M3		5					+	+					+		V-V		
23M4	Alternaria	15					+	+					+		G		
23M5	Hormodendrum	50					+	+					+		Bl		Soil
23M6	Aspergillus	10					0	+					+		Bl-V		
23B7	Flavobacterium	10	—	0	+	0.6X1.0	0	0	0	0	0	B,R	0	0	Y		Soil
23B8	Flavobacterium	10		0			0	0	0	A	A	A,R	+	0	OR		Soil.
23B9	Flavobacterium	30	+	0	+	0.9X1.5	0	0	0	0	0	B	0	0	Y		Soil
23B10	Flavobacterium	15	+	0	+	0.5X0.7	0	0	0	0	0	A,P,R	+	0	OR		Soil
23B11		10	—	0	+	0.9X1.1	0	0	0	AG	AG	R,P	+	NO_2^-	O		
23M12	Hormodendrum	90					+	+					-	+	G-Bl		

SAMPLE NO. 22

DESCRIPTION. Locks from new bolls Texas cotton

DATES. Collected — Sept. 15, 1933 Cultures made — Sept 30, 1933.

TOTAL COUNTS

Culture media	Bacteria	Molds	
Czapeks agar acidified		490,000, 610,000	per gram
Synthetic malt agar		419×10^6, 1.05×10^6	
Nutrient agar	530×10^6; 580×10^6		
Cotton extract agar	520×10^6; 550×10^6		

PURE CULTURE CHARACTERISTICS

No.	Genus	%	Microscopical				Cultural										Habitat
			Gram stain	Spores	Motility	Size in μ	Cellulose	Starch	Dextrin	Maltose	Glucose	Litmus milk	Gelatin	Nitrate agar	Chromogenesis		(Probable)
22M1	Hormodendrum	60					+	+					+		G-Bl		Soil
22M2	Fusarium	10					+	+					+		W		
22M3	Fusarium	40					+	+					+		P		
22M4	Hormodendrum	70					+	+					+		G		Soil.
22B5		15				0.6X1.1											
22B6		15															
22B7		15				0.6X1.5											
22B8		15				0.5X0.7											
22B9		40				1.3X1.5											
22B10	Flavobacterium	25				0.4X1.6	0	0	0	0	0	R	0	0	Y		Soil
22B11	Flavobacterium	10				0.3X0.7	0	+	0	0	0	R-C B,R	+	NO_2^-	Y		Soil

SAMPLE NO. 25

DESCRIPTION. New bolls, Louisiana cotton

DATES. Collected—Aug 8, 1932. Cultures made—Oct 21, 1933

TOTAL COUNTS.

Culture media	Bacteria	Molds	
Czapek's agar acidified		60,000 , 43,000	per gram
Synthetic malt agar	57x10⁶, 5.6x10⁶	390,000 , 360,000	
Nutrient agar	25x10⁶ , 22x10⁶		
Cotton extract agar	13x10⁶ , 16x10⁶		

PURE CULTURE CHARACTERISTICS.

No.	Genus	%	Microscopical				Cultural										Habitat
			Gram stain	Spores	Motility	Size in μ	Cellulose	Starch	Dextrin	Maltose	Glucose	Litmus milk	Gelatin	Nitrate agar	Chromogenesis	(Probable)	
25M1	Fusarium	60					+	+					+		W		
25M2																	
25M3	Staphylotrya	10					+	+					+		G-Bl	Soil	
2584		25		0	+		0	0	0	AG	A.G	P.A	0	NO_2	0		
2585																	
2586		10		0	+		0	0	0	0	0	0	+	0	Y		
2587		10		0	+		0	0	0	0	0	B	+	0	Y		
2588		10		0	0		0	0	0	0	0	0	+	0	Y		
2589		10		0	0		0	0	0	0	0	B	+	0	Y		
25810		10		0	0		0	0	0	0	0	0	+	0	BR		
25811		15		0	0		0	0	0	0	0	B	+	0	Y		
25812				0	+		0	0	0	0	0	0	+	0	Y		

SAMPLE NO. 24

DESCRIPTION. Bolls, Texas cotton

DATES. Collected—Sept 21, 1933 Cultures made—Nov 6, 1933

TOTAL COUNTS.

Culture media	Bacteria	Molds	
Czapek's agar acidified		1.0x10⁶, 1.25x10⁶	per gram
Synthetic malt agar	71x10⁶ , 86x10⁶ ,	1.45x10⁶, 1.58x10⁶	
Nutrient agar	205x10⁶, 185x10⁶		
Cotton extract agar	115x10⁶ , 130x10⁶		

PURE CULTURE CHARACTERISTICS.

No.	Genus	%	Microscopical				Cultural										Habitat
			Gram stain	Spores	Motility	Size in μ	Cellulose	Starch	Dextrin	Maltose	Glucose	Litmus milk	Gelatin	Nitrate agar	Chromogenesis	(Probable)	
24M1	Hormodendrium	40					+	+					+		G-Bl	Soil	
24M2	Hormodendrium	20					+	+					+		G-Bl	Soil	
24M3	Alternaria	5					+	+					0		Dr-Bl		
24M4		5					+	+					+		P		
24M5	Fusarium	5					+	+					+		P		
24M6	Sporotrichum	5					+	+					+		W-R		
24M7	Hormodendrium	85					+	+					+		G		
24M8							+	+					+		W-Gr		
2489		10															
24810	Flavobacterium		+	0	+	0.5x1.5	0	0	0	0	0	R	+	0	Y	Soil	
24811			−			0.4x1.3											
24812	Flavobacterium	15	−	0	+	0.4x1.2	0	0	0	0	0	BPR	+	0	Y	Soil	
24813		10	±			0.5x0.9											
24814		10	+														
24815	(A Yeast)	10	+			1.5x3.0	0	0	0	0	0	0	+	0	Y		
24816	Flavobacterium	10	+	0	+	0.9x1.0	0	0	0	0	0	PR	0	0	Or	Soil	
24817		10															
24818																	
24819	Flavobacterium		+	0	+	0.7x0.8	0	0	0	0	A	PR	+	0	Y	Soil	
24820	Flavobacterium		±	0	+	0.8x1.0	0	0	0	0	0	PR	+	0	Y	Soil	

and plating out the samples for counting. During that period the samples were stored at 20° C. in the dark.

A fresh sample of picker waste was taken at the same time from the opening room of the mill, and in a similar manner.

The data so far obtained from these fresh mill samples consist of observations of the total counts, the relative abundance of colony types and tentative identifications of the kinds of molds found as contaminants. As comparison of this data with that obtained from other sets of samples is material for an interesting discussion concerning the micro-flora of the fibres, these data are cited in Table I.

TABLE I

Total Counts

Sample Group	No.	Bacteria		Molds	
		Number	Log_{10} No.	Number	Log_{10} No.
I. Cotton bolls	22	520×10^6	8.716	620,000	5.793
	23	36×10^6	7.556	460,000	5.663
	24	195×10^6	8.290	1,130,000	6.053
	25	27×10^6	7.432	50,000	4.699
II. Baled cotton					
Outside bale	37	58×10^6	7.764	400,000	5.602
	39	7.6×10^6	6.876	275,000	5.440
Inside bale	36	4.0×10^6	6.602	400,000	5.602
	38	13.4×10^6	7.114	120,000	5.079
III. Picker waste	35	145×10^6	8.162	1,250,000	6.097
IV. Cotton bolls (Stored 6 mos.)	24	16×10^6	7.220	55,000	4.699
V. Stored raw cotton	3	2.2×10^6	6.343	100	2.000
	11	38,500	4.586	670	2.833
	13	830,000	5.920	65	1.813
	16	124,000	5.094	2,250	3.352
	18	150,000	5.176	350	2.542
VI. Stored sliver	12	37,000	4.568	85	1.929
	17	63,000	4.800	77	1.687

Additional Observations

In consequence of the different relative abundance of several types of micro-organisms on the various fibre samples, each set of samples gave rise to plates of characteristic appearance. From the stored samples of sliver and raw cotton came nutrient agar plates bearing a few molds, and an abundance of bacteria, the latter being about evenly divided into yellow and colorless forms. Czapek's agar plates made from the same set of samples usually contained many black and white colonies of *Aspergillus* and a few *Penicillia*, usually dull green.

This was very different from the brilliant display of colors witnessed on plates made from samples fresh from the fields, or from bales at the mill. In this case, nutrient agar plates were largely occupied with yellow colonies, probably *Flavobacterium*, interspersed with a few colorless *Achromobacter* and occasional pink, red, orange, and brown colonies. Czapek's agar plates from the reverse side, due to a profuse growth of *Hormodendrum*, dark green or black, *Fusarium*, white or light salmon pink, *Sporotrichum*, white and red, *Alternaria*, dark green, and some unidentified forms giving rise to brilliant rose red and orange-red colors, had a characteristic "frozen pudding" appearance. Colonies having the appearance of *Aspergilli* and *Penicillia* were also present, but of rare occurrence.

Number of Contaminants

Of primary interest in the foregoing records is the number of microorganisms found on various types of cotton fibre samples. These are briefly summarized. The counts here recorded are the average of two counts for each sample, obtained by the use of nutrient agar and Czapek's Sol. Agar, for bacteria and molds respectively. Comparison of the figures obtained indicates that it is the order of magnitude of the counts which is significant, rather than the actual number of organisms found for any particular sample.

Here is evidence for the formulation of an answer to one of the original questions, answers to which are being sought in the present research: What is the normal, or usual, contamination of commercial cotton fibre? The present data indicate that this may range from: bacteria, 37,000/gram; molds, 77/gram in an old sample, to: bacteria, 520 million/grams; molds, 1.13 million/gram in a sample of unginned fibre. It is probable that the degree of contamination of newly ginned fibre may be in excess of the latter figures, which were observed in the case of samples containing seeds which decrease the size of a gram sample by increasing its specific gravity, but which probably contain fewer organisms than the fibres surrounding them. Samples freshly taken from bales indicate that a degree of contamination which may be expected in a good grade of raw fibre is: bacteria, 1–100 million per gram; molds, 100,000–500,000 per gram. This is somewhat higher than the figures quoted by Fleming and Thaysen[2] for samples of American cotton, which are as follows:

TABLE II

	Bacteria	Molds
Seed Cotton	220,000	4,000 per gram
Ginned Cotton	1,200,000	1,000 per gram
Cotton after pressing	7,000,000	20,000 per gram

It is possible that these counts may be low as a whole because of a short aging of the samples made necessary by overseas shipment. The very low mold counts are probably the result of the use of protein media for making plate counts, rather than the more favorable carbohydrate media used in the present research.

Considering the magnitude of counts obtained in the case of unstored samples, as compared to those in the case of stored samples, it is evident that far fewer organisms were found after storage. This suggests a high

death rate among the molds and bacteria upon a fibre sample during a year of storage in the dark at room temperature. The fact that the microbic population of sample No. 24 declined quite markedly during a six months' period of storage, together with observations later to be discussed concerning the types of organisms present in each sample-group, bear out this suggestion.

Comparing the sample-groups with regard to the treatment which they have received prior to the time of analysis, it may be noted that mechanical fibre-cleaning treatments apparently do not greatly change the degree of contamination of the fibre. The magnitude of contamination of seed cotton; baled, ginned, raw cotton; and picker waste was found to be nearly the same. Similarly, the microbic content of stored raw cotton and stored sliver are of nearly the same magnitude. These comparisons suggest that the contaminating bacteria and molds are about evenly distributed between the waste and the "clean fibre."

Since it has been observed in the laboratory that the growth of both molds and bacteria is much more vigorous in the presence of bits of leaves, twigs, dirt, fly, etc., which comprise the waste material in raw cotton, it may be inferred that the presence of a high degree of contamination in cotton sliver arises in one of two ways: (1) it is evenly distributed on the cotton and waste material in the form of dust; (2) the contaminants have grown on the leaves and stems of the plant, and have been evenly mixed with the fibre during ginning and the cleaning processes. From the study of raw cotton bolls containing seeds, but no bits of leaves and twigs, the former line of reasoning seems the more tenable. A study of the amount of contamination on cotton fibres cut from the seeds of recently harvested bolls is needed to settle the question.

Types of Micro-organisms Found

Upon consideration of the types of micro-organisms occurring on the different sets of samples, the division into newly collected and stored samples is again readily accomplished. The stored raw cotton and sliver have a flora which is characteristically molds of the genera *Aspergillus* and *Penicillium*, and bacteria of the genera *Bacillus* and *Flavobacterium* (Bergey [8]), and a few forms of bacteria which were short lived on nutrient agar and died before they could be studied culturally. Of all these, a black *Aspergillus* was the most abundant. In the case of the newly collected samples, however, these organisms, with the exception of members of the genus *Flavobacterium*, were found only in very small numbers (*Aspergillus* and *Penicillium*) or were not seen at all (*Bacillus*). Large numbers of pigment-forming bacteria and molds of the genera *Hormodendrum*, *Fusarium*, and other mold types abounded.

This suggests once more that large numbers of molds and bacteria have died during the course of a year's storage. It seems that the highly resistant spores of *Bacillus*, *Aspergillus*, and *Penicillium* have alone survived the long period of drying and starvation. It will be noted that, on this basis, they comprise about 1% of the total population of the unstored samples. Hence, their presence would not be recognized by their isolation in pure culture from the fresh samples.

Tentative specific identifications of cultures, and previously reported habitats of members of the genera whose members were isolated in the

course of the experimental work, suggests that most of the contaminants are saprophytic organisms common to the soil. This, together with the fact that freshly picked bolls have a very high degree of contamination, make it evident that the original and principal contamination of commercial cotton fibre is from the soil. Experimental evidence from samples of baled cotton shows that a large percentage of the original contamination is still present in baled cotton at the time that it enters the course of manufacturing processes.

Significance of the Contamination

It has already been suggested that the microbic population of cotton fibre is not greatly diminished by ginning and mechanical cleaning processes. That it is possible for molds to persist through spinning, sizing and weaving, has been demonstrated by Koutieichtchikof,[3] who followed the course of contamination through these processes by the use of a raw cotton heavily infected with a black *Aspergillus*. Many of the molds found on samples of well preserved cotton fibres in the course of this study have been identified by other authors as occurring in spoiled samples of cotton fabric.[6] It seems highly probable therefore that the suggestion of Bright, Morris, and Summers[1] that *Aspergillus, Penicillium, Fusarium,* and *Alternaria* are capable of surviving the processes of spinning and weaving is correct.

As to the bacterial contaminants, it is probable that many of the spore-formers, if not many of the less resistant forms, remain alive on the fibres to the final manufacturing processes. Trotman and Sutton[7] have published results of experimental work which show that *Bacillus subtilis* and *Bacillus mesentericus* may grow upon cotton fibre and cause it to deteriorate if its moisture content be allowed to rise above 9%. Many soil bacilli similar to these were isolated from stored samples during the present investigation. In this case there is evidence to show that they represent the initial population as survivors, rather than members added by growth on the fibre during storage. It would therefore be expected that freshly collected samples would be contaminated to a similar degree with soil bacilli.

The results of studies of the abilities of the pure cultures to utilize certain food substances often associated with raw cotton fibre and its processing, induce discussion as to the probable significance of the fibre flora with regard to changes which would be expected in the presence of suitable conditions of moisture, temperature, and aeration.

This study has served to indicate that the bacterial flora of cotton fibre is probably of minor importance in this respect. Perusal of the data sheets indicates that the principal changes to be expected from the bacterial contaminants in samples of stored fibre, with their population of *Bacillus* and *Flavobacterium*, is a digestion of the protein materials associated with the fibre. Little action would be expected with regard to the cellulose of the fibre, or starch sizing and its degradation products, with the exception of acid production from glucose. The same sort of thing, with perhaps a greater degree of pigment formation, would be expected in the case of freshly collected samples. No marked effects of fibre weakening or dissolution would be expected from this population. This view is supported by the work of Thaysen and Bunker[6] and by preliminary observations in this laboratory. The fact that the bacteria may produce acid and other end-products favorable to mold growth, or conducive to other

forms of change in the fibre, should not be overlooked in considering them to be of minor importance as contaminants.

The action of the molds on the experimental culture media is in marked contrast to the action of the bacteria. They may be divided into two groups: (1) *Penicillium* and *Aspergillus*, characteristic of the stored samples; (2) *Hormodendrum, Alternaria, Fusarium, Sporotrichum,* and *Monilia*-like organisms common to the fresh samples. Members of the first group were found to grow, as a rule, upon cellulose, starch, agar, and gelatin as sole sources of carbon, quite slowly and with a gradual destruction of the substrate. Members of the second group were found to grow with much greater ease upon the same test media, and often with considerable discoloration and evidences of breakdown of the substrate, especially in the cases of cellulose, starch and gelatin.

From the experiments with artificial media, therefore, we should expect the molds to be quite actively involved in changes produced aerobically in damp raw cotton, sized fibre, sized fabrics and sizing materials. Unstored samples would be expected to deteriorate much faster than stored samples, because of their high degree of contamination with swiftly growing molds with ability to make ready use of many food substances.

Appendix

Synthetic Carbohydrate Media

Cellulose broth and starch agar, which contained no source of carbon other than the carbohydrate added, were prepared by addition of these compounds to a basic salt solution. These were prepared as follows:

(*a*) Basic salt solution.

NH_4NO_3	0.50 gm.	K_2HPO_4	1.00 gm.
NaCl	0.50 gm.	$FeSo_4.7H_2O$	0.01 gm.
KCl	0.50 gm.	Water (distilled)	1000 ml.
$M_gSO_4.7H_2O$	0.50 gm.		

(*b*) Cellulose broth.

Tubes were filled with approximately 10 ml., and a piece of Whatman's No. 1 filter paper was one-half submerged in the liquid.

(*c*) Synthetic starch agar.

To one liter of the basic salt medium is added 10 gms. of pure starch and 15 grams of a good grade of agar-agar ("Bacto").

Purification of Dextrin

Technical, white dextrin was purified for use in culture media by the following procedure:

1. To 100 gm. dextrin, technical, add 10 aml. H_2O, distilled, and 300 ml. C_2H_5OH (95%).
2. Allow to stand over night.
3. Filter.
4. Wash residue once with 70%, by volume, C_2H_5OH; then twice with 95% C_2H_5OH. Each time the wash should amount to 100 ml. of solvent.
5. Dry on a porous plate at 70° C.

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Testing the Crêpage of Yarns Before Weaving

By DR. IRVING J. SAXL *

Summary

In view of the importance of investigating the crêpage of individual yarns before their going into production, a new apparatus has been designed with which the crêpage of yarn samples can be determined previous to their being woven into cloth. By the contraction of the yarn, a drum is rotated and a pointer attached to the drum directly indicates the shrinkage of the sample. For bringing the yarn into contact with the solution, under uniform conditions, the latter is heated electrically and the temperature is controlled thermostatically.

Introduction

AN important factor in the construction of fabrics is the mechanism of shrinkage, such as shown in the crêpage of yarns. Not only is it of importance to select proper materials and to adjust the turns twist of thrown yarns so that a definite, predictable crêpage will take place in the fabric, but, in addition, also the reversal of the problem has significance, namely, the determination of the limitation of shrinkage, *i.e.*, that fabrics subjected to laundering processes shall not shrink beyond a given limit of tolerance.

Research in the field of crêpage is particularly important in high-twist yarns and spun yarns where it is imperative to investigate the influence of the original quality of the yarn used, its chemical and physical structure, its method of processing, such as number of turns per inch, conditioning, steaming, etc., upon the final crêping qualities. For bringing about optimum results the determination of the crêpage of the individual yarn is therefore imperative.

Investigations for the purpose of determining shrinkage have been carried on heretofore mostly by making samples of the material and processing it in the regular way after weaving. The difference between width in the loom and width of the flat laid material after the boil off was taken as a means for determining the degree of crêping. This method has the disadvantage of necessitating the use of finished goods with its inherent loss of time and material. If a piece of yarn is already in the loom and it is inferior, it is then too late. Moreover, it is necessary to know how

* Director Research and Development, The Waypoyset Mfg. Co., Central Falls, R. I.

much a yarn is going to shrink in a given cloth construction *before* it goes into the cloth. Furthermore, individual lots of yarn coming from different sources and thrown on different frames should be compared objectively before they are passed into production. A new instrument has been developed, therefore, with which the crêping qualities of individual samples of yarn can be measured exactly, previous to their being woven into material.

The Construction of the Crêpage Tester

Fig. 1 is a picture of the complete apparatus. In a supporting frame of steel tubing are held two main parts which can be moved relative to

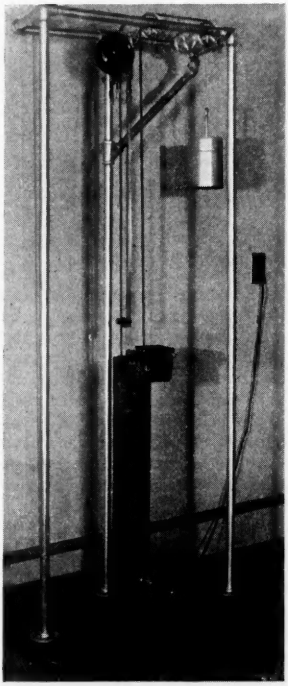
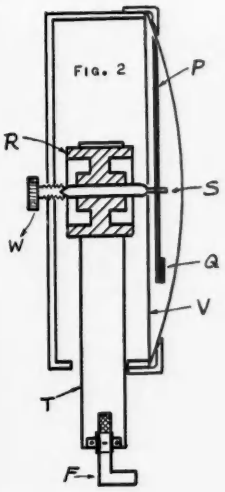


FIG. 1



each other. These are a movable tank with counterweight containing the heated boil off solution, and the yarn to be tested (or a strip of fabric) attached to its holder with indicating device.

A piece of yarn, two feet in length, is fastened between one fixed lower- and one movable upper-clamp. The lower-clamp is covered with rubber or

some other heat insulating material so that it can be operated, despite the fact that it becomes warm during the testing procedure. The movable clamp (F) is fastened to a piece of tape (T) or thin chain which is wound around a drum. (See diagram of cross-section Fig. 2.) Thus, if the yarn shrinks, it pulls the upper clamp down and, accordingly, the drum rotates. The drum is easily movable on an axle of hardened steel (S), to which is attached a pointer (P), with balance (Q). A countersunk set-screw (W) holds the axle, centered accurately, and with a minimum of friction. The motion of the tape (T) upon the drum (R) is transmitted to this pointer (P). It rotates over a dial (V) which is calibrated in inches contraction, or in total percentage contraction of the length of yarn used. A flat tape is used for the purpose of making sure that no turn of the yarn will be lost. To prevent the tape from slipping upon the drum, small spokes may protrude from the drum which engage openings in the tape.

The other side of the tape is held down by a small weight (w) (Fig. 3). The weight is so chosen that the yarn does not show kinks if subjected to shrinking. There is an optimum weight; it must be chosen in such a way as to partially counterbalance the clamp (E) and to hold the yarn back moderately so that it does not kink. Furthermore, the weight must be small enough so that the very small force exerted by the shrinkage of the yarn is sufficient to move the tape. In actual work with 240 denier spun rayon a counterweight of 0.3 gram has proven suitable.

The Boil Off Solution

The boil off solution is kept in a cylindrical container about 2½ feet high and 6 inches wide. As can be seen from Fig. 1, the vessel is counterbalanced by a weight. It can thus be raised on a pulley so that the yarn, fastened to its holder, is fully submerged. For simplifying the exchange of the solution a faucet is attached at the bottom of the receptacle. On top of this container, and protruding from its right side, is the controlling unit for the heating element. For keeping the height of the fluid constant, a leveling device is attached to the receptacle; thus the solution is also in equilibrium with the counterweight. Instead of raising the boil-off solution, it would be possible, in a different construction, to lower the yarn-holder.

The Heating Circuit

For keeping the boil-off solution at a constant temperature, an electrical heating element with a thermostatic current regulation has been used. Fig. 4 shows a schematic diagram of the heating circuit. The coil (A) dips into the liquid. The current, coming from the contact plug (B), passes the thermostatic contacts (C) and goes from there to the Neon lamp (D), in parallel with the coil (A). The condensers (G) and (H) are placed in parallel with the contacts in order to reduce arcing. The lamp indicates whether the electric current is flowing or has been interrupted. A double contact has been used so that the distributed current load per contact is only about 2½ amperes, which is a reasonable load for continuous service. It may be mentioned that this thermostatic regulator is of a strictly mechanical construction and it has thus been possible to avoid the use of

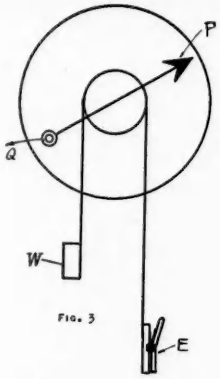


Fig. 3

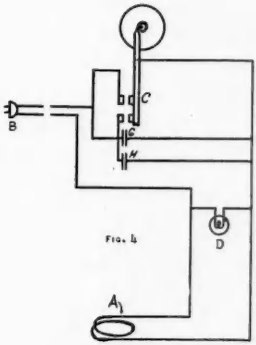


Fig. 4

intricate secondary relays. According to the type of yarn treated the temperature of the boil-off solution can be kept constant with this device within $\pm$ 0.5° F. at temperatures between 190–210° F. (about 88–98° C.).

For making a crêpage measurement a length of 50 cm. of yarn is inserted in the testing device. Thereafter, the vessel, containing the boil-off solution, is raised so that the total length of the yarn is immersed in the soap solution within the vessel. The yarn shrinks and, in doing so, pulls the movable clamp and the tape to which it is attached in the direction of the fixed clamp. Accordingly, the pointer moves, and, inasmuch as its length is greater than the diameter of the drum, the exactness of the readings is increased in proportion to it. In the present form the dial has 4½ inches diameter and its total periphery indicates 8 cm. contraction, so that a high degree of accuracy is achieved.

Abstracts

This section is compiled under the direction of the Committee on Abstracts and Bibliography: Prof. E. R. Schwarz, Chairman, Dr. W. E. Emley, Prof. Louis A. Olney and M. W. Weiss.

I. Fibres (Synthetic and Natural) and Fibre Analysis

Acetylated Cotton. E. Chippindale. *Tex. Wld.*, July, 1934, P. 75.

This is an abstract of a paper presented by Mr. Chippindale of the Manchester (England) Section of the Society of Dyers and Colourists, and describes the manufacture and properties of a new type of textile produced by the low acetylation of cellulose fibres. It is stated that the new material combines the strength and structure of cotton with the dyeing properties of the acetate rayon.

Note: A similar discussion is to be found in the *J. Soc. of Dyers and Col.* on page 142 and is an abstract of the original paper which was presented before the Manchester Section of the Society, Decemmber 15, 1933, and includes some six excellent photomicrographs of fibre cross-sections together with additional information concerning many of the recent British patents and with other features. Further, there is a discussion of the whole subject matter by other members present. (S)

Cellulose: Constitution of. H. Staudinger. *Chem. Ztg.*, 1934, V. 58, P. 145–48.

The specific viscosity of a dilute solution is essentially a function of the length of the mol. and is unaffected by the chemical nature of the solute. Thus, the mol. wt. of cellulose is best calculated from its viscosity in Schweizer's reagent, and investigations with celluloses of different origin have given the value 120,000. The cellulose mols. are very long, thin, elastic rods and the ratio, length: breadth = 500: 1. The length of the chain is 4,000 Å, and the degree of polymerization ranges from 10 for cellodextrin to 750 for cotton linters and 1,000 for ramie cellulose. The physical properties of the cellulose fibres depend upon the degree of polymerization, the higher polymers being stronger, less soluble and possessing greater swelling power than the lower polymers. The shape and size of the cellulose mol. also explains its chemical properties, the remarkable strength of dry cotton threads being due to the parallel arrangement of the long mols., whilst degradation of cellulose in solution by chemical influences or light increases with the degree of polymerization. Nitration of cellulose does not involve degradation of the mol. and, therefore, cellulose nitrates can be obtained which yield solutions the viscosity of which is comparable with that of the original cellulose. In the acetylation of cellulose, on the

other hand, some degradation occurs and the cellulose acetate rayons of commerce have a polymerization value of 150–200. (Copied complete from *J. Soc. Dyer and Col.*, May 1934, P. 156.) (S)

CELLULOSE PULPS: HYDRATION AND BEATING OF. W. Boyd Campbell. *Ind. and Eng. Chem.*, February, 1934, P. 218–19.

The author discusses the deductions from vapor pressure curves which indicate conditions during hydration and beating of cellulose pulps, conditions at crystallite surfaces, how fibrillation causes increased strength and density in the resulting paper and gives certain mathematical derivations in suport of his hypothesis. The author makes no claim that proof of the ideas presented has been made. They must be looked upon simply as the author's interpretation of the available evidence. A short literature summary is cited. (S)

CELLULOSES: MOLECULAR WEIGHTS OF. Elmer O. Kraemer and William D. Lansing. *Nature*, June 9, 1934, P. 870–71.

A very brief survey of the present information by Mark, Stemm, Staudinger, etc., together with such comments by the author. It is stated that it is suspected by the present writers that degradation inadvertently occurred during Stamm's determinations. The results of the authors would indicate that the cellulose molecular weight ranges from 60,000 to 180,000. They further estimate the molecular weight of native cellulose to be in the neighborhood of 300,000. There is approxmiately twice the value given by Staudinger, which in turn is the maximum value of those quoted. (S)

TEXTILE FIBRES: STRESS STRAIN RELATION IN. R. L. Steinberger. *Physics*, Feb., 1934, P. 53–60.

Stress-strain relations for eight common textile fibres are given (four rayons, silk, wool, cotton and ramie) under known humidity conditions. The method has two novel features: (1) In each experiment the section area was determined on the specific fibre under test; (2) the elongations were made in steps, with a relaxation interval of 30 seconds between stress observations, rather than at a constant rate which is the usual practice. The rayons exhibit an accurately linear initial curve from which Young's modulus can be determined, followed by a yield point and a long region of plastic flow. The curves for cotton and ramie are linear with no plastic yield in the range examined. In silk and wool there is no proportionality between stress and strain. Cellulose acetate exhibits the phenomena of "cold working" and marked increase of total and elastic energy with falling relative humidity. The application of Maxwell's relaxation equation is examined.

Note: This material has been published in *Tex. Rsch.*, Vol. IV, No. 5, P. 207–234. (S)

II. YARNS AND FABRICS

ARTIFICIAL FABRICS AND YARNS, SILKS, ETC.: ON THE MANUFACTURE OF. (German.) V. E. Pallas. *Kunststoffe*, May, 1934, P. 105–7.

A brief description of the necessary factors involved in the manufacture of artificial fabrics and yarns giving attention to conditions of

temperature, viscosity, the character of the original solution and various other properties both physical and chemical which play a part in such manufacture. (S)

ELASTIC PROPERTIES OF VISCOSE RAYON. H. Weinges. *Kunstseide,* 1933, V. 15, P. 282–5, 319–23, 362–5.

A description of the most important elastic properties of viscose rayon, such as total elongation, elasticity, reversible and permanent extension, and a discussion of their relationships to the knitting and weaving processes. (Copied complete from *Chem. Abs.,* 1934, V. 28, Col. 4241.) (W)

EXHAUST GASES FROM A VISCOSE RAYON FACTORY WITH THEIR REACTIONS AND RECOVERY, AND THE USEFULNESS OF THE RECOVERED MATERIAL. (German.) Wilhelm Mang. *Die Kunstseide,* April, 1934, P. 118–22.

The article describes the composition of gases escaping from typical viscose rayon factories together with the reactions occurring in the waste-gas tower where these gases may be absorbed by spraying them with the waste lyes from the production process. Under proper working conditions a sodium sulphide lye may be obtained which can be employed in the desulphurizing of the rayon as it is produced. The article further describes control of the process and the analysis of the lye from the waste gas towers. (S)

FASTNESS IN TEXTILES. C. M. Whittaker. *J. Soc. Dyer and Col.,* June, 1934, P. 165–69.

A brief discussion which the author states is intended to be deliberately provocative so as to give others an opportunity of stating their opinions. In addition to the discussion in brief of light fastness the author passes to fastness to weathering and also tendering effects, fastness to washing, and closes with a brief discussion of fastness to shrinkage. The article is rather general in its whole tone. (S)

HOSIERY DEGUMMING. Rsch. Dept., Procter and Gamble. *Am. Silk Rayon J.,* 1933, V. 52, No. 11, P. 37–8, 44, No. 12, P. 37–8, 56–8; 1934, V. 53, No. 1, P. 37–8, No. 2, P. 37–8.

Hosiery degumming is regulated by the type of finish desired. The finish is dependent upon the amt. of residual sericin left upon the hose after stripping. By properly adjusting the time, temp. and soap concn. of the degumming soln. the residual gum content on the silk can be controlled. The soap and oil-stripping methods are also compared. (Copied complete from *Chem. Abs.,* 1934, V. 28, Col. 4603.) (W)

JUTE BATCHING (OR SOFTENING). W. E. Billinghame. *Tex. Mfr.,* 1934, V. 60, P. 65.

The process of softening jute before spinning is known as batching. Whale and fish oils were first used for this purpose, later mixed with mineral oil. These are not emulsified but the oil is applied either before or after wetting the jute with H_2O. This oil-and-water softening is no longer considered satisfactory as the results are generally very uneven. Emulsions of oil in water wet-out the jute more evenly and give a softer, stronger, cleaner, cheaper and more regular yarn with less waste. In prepg. the emulsion, the emulsifier should have lubricating, stabilizing, cleansing, pene-

trating, wetting and solvent properties. The mineral oil should be as colorless and odorless as possible and should not discolor in light and air. Whale oil usually develops odor and rancidity. The H_2O used should be soft and clean. Water-in-oil emulsions are not suitable for soft fibres but are ideal for hard fibres, such as manila, sisal, etc. As an example, an emulsion contg. 7lb. of pale mineral oil, 1 lb. of emulsifier, and 16 lb. of H_2O is applied to 100 lb. of jute at 50° to 60°, or if a more rapid action is desired, at 88°. A stronger emulsion can be used for carpet and linoleum backing, where the color is less important. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4238). (W)

MILDEW ON WOOL: CAUSES AND PREVENTION OF. R. Burgess. *J. Soc. Dyer and Col.*, May, 1934, P. 138–42.

This is a paper accompanied by a discussion which was presented at the Bradford meeting of the West Riding Section on December 7th, 1933. The author discusses factors influencing mildew developments, prevention of mold growth, the application of antiseptics during the winding process, and during the backwashing process, during oiling of the wool, and the use of volatile antiseptics, other beneficial treatments, defects due to contact with paper cones, bacterial action on wool, and bacteria as a cause of premature deterioration of wool bathing suits in the tropics. (S)

SILK: DECOMPOSITION OF. Milton Harris. *Am. Dye. Rptr.*, July 16, 1934, P. 403–5.

The purpose of this investigation was to study the deterioration of silk on exposure to daylight under natural conditions of use. The strength of silk cloth decreased and its ammonia nirtogen content increased on exposure to sunlight. Samples of the cloth treated with a tenth normal solution of sodium hydroxide showed smaller changes, and samples treated with a tenth normal solution of sulfuric acid greater changes, than the untreated cloth under the same conditions. Similar results were obtained on exposure of samples to north skylight. Samples treated with sodium carbonate solution of one per cent or less in concentration showed the greatest stability. The amino nitrogen content was the same for silk stored in the dark and silk exposed to sunlight for three months. The rate of hydrolysis in 0.5 normal sodium hydroxide solution, measured by the formation of amino nitrogen, was the same for both samples. The decrease in breaking strength and increase in ammonia nitrogen content of silk on exposure to light are brought about by atmospheric oxidation in the presence of light. The results of these experiments are in accord with those obtained in the accelerated ageing tests of silk, using the carbon arc lamp as a light source. (S)

III. CHEMICAL AND OTHER PROCESSING (NOT OTHERWISE CLASSIFIED)

DYES: BIBLIOGRAPHY OF RUSSIAN RESEARCH ON. Published in 1917–1932. A. E. Porai-Koshitz. *J. Applied Chem.* (U. S. S. R.), 1933, V. 6, P. 755–63.

Two hundred and sixty-nine references. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3905.) (W)

DYES OF THE INDANTHRENE TYPE: PRESENT STATE OF KNOWLEDGE OF. Max A. Kunz. *Bull. soc. ind. Mulhouse,* 1933, V. 100, P. 3–50.

An address. The subject is thoroughly discussed, and mention is made of some expts. of K. on dianthrone derivs. (Copied complete from *Chem. Abs.,* 1934, V. 28, P. 3235.) (W)

ELECTROLYTIC ADSORPTION OF IRON ON VISCOSE RAYON AND OTHER FIBRES. K. Tanemura, H. Kohno and K. Nishimura. *J. Soc. Chem. Ind. Japan* 37, Suppl. binding 1934, P. 89–90; *Chem. Abs.,* 1934, V. 28, P. 3239. (W)

FIXATION OF METAL IONS BY ANIMAL HAIR. Joseph Caspe and Wm. E. Austin. *J. Tech. Assoc. Fur. Ind.,* 1933, V. 4, P. 12–18; *Chem. Abs.,* 1934, V. 28, P. 3239. (W)

FILLING AND WEIGHTING WOOL TEXTILES. F. C. Pratt. *Tex. Mfr.,* 1933, V. 59, P. 494.

Woolens are sometimes stiffened by a paste contg. one lb. of sago flour in 2.5 gals. H_2O, prepd. by boiling 0.5 hr., and applied cold in a dolly. Deliquescent salts are used for weighting worsted, including the chlorides of Zn, Mg, Al and Ca, in the order of decreasing importance. Fe-free $ZnCl_2$ soln. of 10–14° Tw. contg. some glycerol is probably most satisfactory and is applied in a lecker or by padding. The addn. of one lb. of Eulan W Extra or two lb. of Eulan NK per 24 gal. of H_2O obviates mildew. Eulan N is applied from an acid bath and will give up to 10% weighting, is fast to washing and eliminates both moth and mildew. (Copied complete from *Chem. Abs.,* 1934, V. 28, P. 3908.) (W)

FADING OF DYESTUFFS UNDER ULTRA-VIOLET LIGHT, AND A MEANS OF MAKING THE TEST. G. A. Bravo. *Industria chimica,* 1934, V. 9, P. 313–19.

A soln. of dye is used to stain a piece of filter paper, which is then exposed to ultra-violet radiation. A fan keeps a currnet of air moving over the samples for cooling purposes. In this way, a large no. of com. dyes have been tested and classified. It is recognized that ultra-violet light does not exactly simulate the action of sunlight, but merely affords a convenient test method. (Copied complete from *Chem. Abs.,* 1934, V. 28, Col. 4238.) (W)

FILLERS AND WEIGHTING PIECE GOODS. J. A. Clark. *Tex. Mfr.,* 1934, V. 60, P. 123–5; *Chem. Abs.,* 1934, V. 28, Col. 4242.

The prepn. and properties of china clay, talc or French chalk, $CaSO_4$, satinite or gypsum, Mg silicate, $MgSO_4$, $MgCl_2$, $CaCl_2$, $ZnCl_2$, glycerol, glucose and starch are discussed. (W)

HYDROLYSIS OF WOOL: EFFECT OF NEUTRAL SALTS ON THE—WITH ACIDS AND BASES. Eugen Kimmel. *Bull. soc. chim. România,* 1933, V. 15, P. 121–7.

Pure wool was treated with various concns. of HCl, H_2SO_4 and NaOH resp., in the presence of various salts. By using 0.1% HCl and adding NaCl up to 100 g. the hydrolysis was only slightly increased; 0.1% H_2SO_4

hydrolysis produced a retardation when Na_2SO_4 is added. Various known concns. of NaOH contg. Na_2CO_3 or Na_2SO_4 caused retardation. When very dil. NaOH (0.00125 *N*) was used at 100°, Na_2CO_3 and Na_2SO_4 have a marked accelerating effect. These salts act as alkalies themselves. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3591.) (W)

INDIGOSOLS FOR FOULARD DYEING. L. Caberti. *Rev. gén. mat. color.*, 1934, V. 38, P. 185–8; cf. *Bolletino della cotoniera* (Bolletino technico), 1933, V. xii, P. 190–3.

Indigo sols are better than vat colors since they give prints in solid color with brilliancy and provide even shades by simple means. Vapor and nitrite processes are described. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4236.) (W)

INSOLUBLE PRODUCT BY OXIDATION OF *p*-NITROAMINOPHENOL. Hirsch-Pomerantz. *Bull. soc. ind. Mulhouse*, 1934, V. 100, P. 115. (Sealed Note of 1912.) Report. Rene Speitel. *Ibid.*, P. 116; *Chem. Abs.*, 1934, V. 28, P. 3906. (W)

METHYLENE GRAY MUST FIND AN APPLICATION IN TEXTILE INDUSTRY. D. A. Gulyaev. *Anilin. Prom.*, 1934, V. 4, P. 32–4.

A discussion is given with some recipes of dyeing and printing tannic-acid-mordanted cotton with Methylene gray, a by-product in the production of Gallocyanin DN and Gallamine blue. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3589.) (W)

MONO AZO DYESTUFFS AND LAKE COLORS AND THEIR APPLICATIONS. A. H. Whitaker. *J. Oil & Colour Chem. Assoc.*, 1934, V. 17, P. 168–84.

The constitution, prepn. and general pigment properties of the mono-azo dyestuffs are briefly described. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4910.) (W)

PIGMENTS AND LAKE COLORS AND THEIR APPLICATION. A. H. Whitaker, *J. Soc. Dyers & Col.*, 1934, V. 50, P. 169–74.

A brief discussion of a no. of important individual colors. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4910.) (W)

PYRIDINE AND ULTRA-VIOLET LIGHT: APPLYING DECORATIVE DESIGNS ON FABRICS BY MEANS OF. Photopyridine Colors. H. Freytag. *Monatschr. Textil-Ind.*, 1933, V. 48, P. 107–8, 130–1; *Chim. & Ind.*, V. 31, P. 621.

The fastness of photopyridine colors can be improved by coupling with diazotized bases. The sample, impregnated with fuel alc. and C_5H_5N, is allowed to stand on a sheet of glass till the alc. has completely evapd., and is then exposed to ultra-violet light for 30–45 min. at 30–50 cm. from a quartz lamp. It is then passed through a boiling acid bath contg. 2–3% of a primary aromatic amine. The color thus obtained lacks fastness; but this is improved by treating (without washing) with a soln. of a diazonium salt of an aromatic base. There is considerable change in the color. The dye is a true azo dye, but its chem. constitution is not yet known; all that is known is that the first dye obtained (after coupling with the acid soln. of primary amine) contains either an azo or an azo-methine group. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3590.) (W)

SILK SCREEN-PRINTING: PHOTOGRAPHIC SCREENS FOR. Carl Hymot. *Rayon and Mell. Tex. Mo.*, June, 1934, P. 41–2.

Due to the fact that until recently such screens were made by hand, they were hardly practical for the production of multi-colored fabrics with great accuracy in rather small quantities. With the aid of photography the worker is now enabled to transfer designs from paper onto the screen and to achieve much better results in accuracy and brilliance of design with less, time, effort and skill. The article contains a brief discussion of the photographic method, the manipulations involved, and the equipment required. (S)

SODIUM NITRITE: ACTION OF—ON SODIUM POLYSULFIDE. I. Khmelnitzkaya and V. Verkhovskaya. *Anilin. Prom.*, 1934, V. 4, P. 27–31; *Chem. Abs.*, 1932, V. 26, P. 4590; 1934, V. 28, P. 3589. (W)

SULFONATED FATTY ALCOHOLS: PURITY AND YIELD OF. L. Bonnet. *Rev. gén. mat. color.*, 1934, V. 38, P. 246–7.

When sulfonated alcs. are used to facilitate uniform dyeing and at the same time to soften fibres, evaluation is not based altogether on direct analysis, but on differences in tinctorial effects, due to Na_2SO_4, CCl_4, C_2HCl_3 and water. A 65% sulfonated alc. should not contain more than 1% Na_2SO_4. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4928.) (W)

VAT DYES: EFFECT OF LIGHT ON CERTAIN. A. Wahl. *Rev. gén. mat. color.*, 1934, V. 38, P. 217–23.

A résumé of observations on certain dyes, used singly and in mixts. on cotton, showed clearly that the alteration or nonalteration of the shade may be due to the effect of light not on the single dye alone but on the entire fibre-dye system. A single dye by itself may fade but in a mixt. with a resistant dye will not do so. The destructive action of certain vat dyes on fibres is linked to the fact that their absorption spectra show a band in the ultra-violet at about 3300–3700 A. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4910.) (W)

IV. RESEARCH METHODS AND APPARATUS

GLOSSMETER. Richard S. Hunter. *Rayon and Mell. Tex. Mo.*, June, 1934, P. 27–8; *Chem. Abs.*, 1934, V. 28, P. 3601.

A brief description of an instrument designed to meet the needs of the paint, varnish, and lacquer industries, but which is applicable to the textile industry as well for the measurement of the gloss of yarn wound in parallel fashion on cards or for lustrous fabrics. The instrument is not recommended for fabrics which do not possess a very high degree of lustre such as loosely knitted fabrics, etc. The instrument is self contained, operates from three small flashlight batteries and is a direct reflective comparison of the reflectance of light from a polished black glass standard and the sample. It is unnecessary to cut samples since the instrument is designed to be placed directly on the surface to be observed. A scale is provided with the instrument which gives the gloss reading for test purposes when the observer has set the lamp in such position as to balance the field shown in the field mirror. (S)

LINSEED OIL SIZES. II. EFFECT OF LINSEED OIL SIZES ON THE EXTENSIBILITY AND STRENGTH OF VISCOSE RAYON. W. Coordt. *Mitt. Textilforschungsanst. Krefeld*, 1932, V. 8, P. 7–12.

After three hours at 105°, the breaking load of unsized rayon was unaffected, while the values for sized rayons were lowered and the pH of the aq. exts. was raised. Generally, the more acid sizes had the greater effect, but acidity was not the only controlling factor. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 2191.) (W)

TEMPERATURE CONTROLLER: NEW TYPE OF SELF-OPERATING. Emil T. Johnson Regulator Co. *Inst.*, May, 1934, P. 97.

A new type of self-operating temperature controller is described with a numbered diagram giving in detail the operation and construction. The regulator is stated to be unusually sensitive since the operation of the valve calls for but 1% of power from the valve itself the other 99% coming from the heat energy of the steam in the valve body. The regulator has a range of 40° F. and is very easily set for adjustment and may be used at either high or low pressure systems. (S)

WEIGHTED SILK: ANALYSIS OF. I. QUANTITATIVE. W. Weltzien, A. Schotte and H. Corsten. *Monatsh. Seide Kunstseide*, 1933, V. 38, P. 199–203.

The material is opened up with concd. HNO_3 and concd. H_2SO_4, treated dropwise with HCl + HBr at 140–180°, and the Sn either distd. off and pptd. with H_2S, or detd. titrimetrically after neutralizing the excess of acid in the distillate with aq. NH_3. SiO_2 in the residue is collected on a filter, and P_2O_5 detd. by pptn. with 8-hydroxyquinoline and a sol. molybdate. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4911.) (W)

WOOL: DETERMINATION OF FINENESS, LENGTH, AND CRIMP OF COMBED—AND THE QUANTITATIVE LISTING OF GERMAN COMBED WOOL TYPES. Dr. Franz and Dr. Mendrzyk. *Mell. Textilber.*, May, 1934, P. 194–96.

A brief review of the literature from 1777 to date is given in the first part of the article. There then follows a discussion of various methods which have been proposed for the determination or measurement of the fineness, crimp, length, and soforth of wool fibres. A number of the so-called rapid lanimeters are described and one is pictured. The article is to be continued in the next issue. (S)

WOOL AND TEXTILE FIBRES: A NEW METHOD OF OBJECTIVELY DETERMINING THE FINENESS OF. H. Doehner. *Rayon and Mell. Tex. Mo.*, May, 1934, P. 43–5.

This is a method which has already been described (see *Mell.*, 1929, V. I, P. 7). Since that time, however, the apparatus has been somewhat improved and it was thought well to give a more comprehensive description of the apparatus at this time. The device now includes a measuring screen which gives the diameter of the fibre at two micron intervals. After the necessary measurements have been taken on say 100 fibres the classes are reported on the abscissa of the fibre width curve while the number of fibres of each individual class is plotted on the corresponding ordinate. The resultant curve shows the data obtained by the measurements in a simple and compact form. The device is essentially a projection microscope which

also can be adapted for simple photography. Provision is also made as in the older instrument for comparison of the specimen with some 8 types of wool shown in direct positive photographs viewed as transparencies. (S)

YARNS AND FILMS OF CELLULOSE ACETATE: DETERMINATION OF THE CONTENTS OF—WITH REGARD TO WATER AND SOLVENTS. (German.) Fritz Ohl. *Die Kunstseide*, March, 1934, P. 79–83.

Single values for the water and solvent contents of commercial cellulose acetate yarns and sheet are reported and their importance for the properties of the material are discussed on the basis of experimental results. The method of test is briefly described. Complete absence of very small quantities of these substances improves the mechanical properties of the cellulose acetate plastics. The influence of residual solvents on the swelling capacity and other characteristics of the yarn and film is explained in detail. (S)

YARNS FOR TEXTURES AND WEAVING: A METHOD FOR THE DETERMINATION OF COVERING POWER OF. Karl Kusebauch. *Mell. Textilber.*, Feb. 1934, P. 55–59.

The article covers an application of the so-called rapid-lanometer which is an instrument for giving an instantaneous reading of the number of yarns per inch at any given point in a fabric by means of an interference diagram. This instrument has been described by Heerman in connection with Prof. Herzog in their joint book on textile testing. Tests which are quoted have given a relationship between the metric number of certain yarns ranging in size from single 11s to two ply 84s. Certain well recognized fabrics and the readings given on the same pieces of fabric by means of the lanometer. In addition to the tabulated data there is given a chart for various types of yarn including both combed and carded. It was found, for example, that a 26s single combed yarn, a 47s two ply combed yarn and a 22s single carded yarn gave the same covering power of an equivalent lanometer reading of 22s for each. (S)

PAPER SMOOTHNESS TESTER. W. and L. E. Gurley. *Instr.*, 1934, V. 8, No. 7, P. 170.

The mechanical measurements of the smoothness of surfaces are made with this instrument where the material tested is available in sheets or thin form such as paper or fabric. A piece of the material is placed between two metal blocks which have been cut into circular cross-sectional area of one square inch and lapped and polished to optical flat. Provision is made to supply water under constant pressure of 12 inches on each side of the sample, and the time in seconds for a given outward air leak between the paper and either block can be taken as a measure of the inequality in the surface finish or in the side porosity of the material. The following advantages are claimed: (1) that both top and bottom sides are measured at the same time; (2) penetrability is determined throughout the sample in a lateral direction; (3) low unit pressure is applied to the sample and causes no change in its structure; (4) portability of the device; (5) easy operation, and (6) a short testing period. The instrument is small, occupying a space of 12¾ inches in height by 6½ inches in the base. (S)